

SEAN T. DOHERTY, Ph.D., *Assistant Professor, Wilfrid Laurier University*
JEAN C. ANDREY, Ph.D., *Associate Professor, University of Waterloo*
LAURA C. JOHNSON, Ph.D., *Associate Professor, University of Waterloo*

The Economic and Social Impacts of Telework

Introduction

Telework raises a variety of issues for employers, employees, families, and communities. This literature review focuses on a specific set of economic impacts of telework,¹ primarily from an employee's perspective. This includes important social implications that are not directly measured in economic terms but have an indirect effect on household, regional and national economies. The specific themes of this review include the following:

1. TELEWORKER JOB TASKS: What are the typical sets of tasks that teleworkers perform?
2. MOTIVATION: What are the push and pull factors for individuals deciding to telework, including wage issues and other factors. Do telecommuters accept a lower wage for the benefit of working at home?
3. PRODUCTIVITY: Does telework lead to greater productivity and/or changes in the number of hours-spent working?
4. ABSENTEEISM and RETENTION: Are any changes in absenteeism or employment retention realized as a result of telework? Do these create cost savings to employers?
5. EQUITY: Has telework assisted any particular groups in obtaining and retaining employment?
6. INDIRECT IMPACTS: What are the other indirect economic and related social impacts of telework (e.g. transportation and the environment, community involvement, land-use development, work-life balance, home workspace)?
7. MEASUREMENT CHALLENGES: What are the challenges to investigating, measuring and understanding the impacts of telework?

This review provides a survey of these issues and assembles research findings from a range of international and multi-disciplinary sources in an effort to assess potential impacts, future trends and challenges. The review is limited in large part to publicly available published documents, including (in decreasing order of prevalence) journal articles, government/consultancy/university reports, books, magazines articles and press releases.

Sean T. Doherty, Jean C. Andrey, Laura C. Johnson © 2000. All rights reserved.

This project was funded under a purchase order contract from the Office of the Assistant Secretary for Policy. Points of view or opinions stated in this document do not necessarily represent the official position or policy of the Department of Labor.

Teleworker Job Tasks

Telework has grown dramatically over the past decade, and most experts forecast even more rapid adoption in the years ahead. Growth projections are based, in part, on recent surveys and job analyses, which suggest that between 25 and 65% of jobs in North America and Europe are at least partly telecommutable (Empirica 1999; Pratt 1999; Ekos 1998, Weijers et al. 1992).

Telecommutable jobs tend to have the following characteristics: a substantial portion of the work consists of creating, manipulating and disseminating information; some of the work results in measurable outputs (e.g., reports, accounts) and can be planned; and many tasks do not require face-to-face contact, physical access to fixed resources, or the use of high-security information (Nilles 1998; Weijers et al. 1992). In other words, telework is well suited to jobs that are information-based, portable and predictable. Furthermore, telework is considered ideal for tasks that require extended periods of high concentration (Gil Gordon Associates 2000).

Teleworkers can now be found in every economic sector. Early teleworkers were mostly in the professions (LINK 1991), and even today teleworkers are usually information workers, with a large proportion holding fairly senior positions, e.g., project/middle/senior management (KPMG 1997). Recently, however, there has been increasing representation of teleworkers at all levels.

Table 1 provides a partial listing of some of the main telework occupations based on a job classification scheme proposed by Stanworth and Stanworth (1991 as cited in Cornford et al. 1997) and details/examples from a variety of empirical studies as well as reference guides on telework (e.g. Nilles 1998, LINK 1991). This table makes it clear that there is no singular mold for telework jobs. Telework tasks/activities also vary significantly from one job and person to another. "The kinds of tasks that are ideal for telecommuting tend to be individually driven, require minimal instructions and checking, need not be performed at set times, and produce measurable results" (Gupta et al. 2000, p. 27). Several studies provide activity summaries (e.g. Gupta et al., 2000; Nilles 1998; Treasury Board of Canada 1996; Statistics Canada 1994) which indicate that thinking/planning, reading/writing, text/word processing, research, analyzing and interpreting data, and other paperwork are the most common tasks. Less widespread, but still important, are specialized tasks such as working with databases, computer programming, graphics/layout, record keeping and accounting/budgeting. More detailed information on teleworkers' job descriptions and activities is being collected on-line by the American Telecommuting Association as part of their Telecommuting Work-Analysis Project, but the summary report is not yet available.

Additional insight into telework job tasks can be gained from examining the use of support equipment. The 1999 National Telework America National Telework Survey provides the following breakdown: teleworkers spend 38% of their work time on the computer; 17% on the phone; 24% doing reading, research or analysis; and 9% in face-to-face meetings (Pratt 1999). Various other studies confirm the high level of dependence on computers, telephones, and related accessories/peripherals/services (Treasury Board of Canada 1996; Gurstein 1995; Rathbone 1992).

Table 1 Typical Telework Occupations

Professional & Management Specialists	Professional Support Workers	“Itinerant” Field Workers	Information Technology Specialists	Clerical and Administrative Staff
accountant	bookkeeper	auditor	data analyst	claims processor
actuary	indexer	inspector	designer	customer service
advertiser	proof-reader	insurance	engineer	data coder
architect	researcher	journalist	graphic artist	data entry staff
author	translator	marketing	programmer	program admin.
consultant	writer	realtor	systems analyst	purchaser
economist		sales person	technician	secretary
financial analyst				word processor
lawyer				
manager				
psychologist				
scientist				
stock broker				
statistician				
trainer				

Motivations

Various estimates have placed the prevalence rate of teleworking at less than 10% of the workforce (Pérusse 1998; Handy and Mokhtarian 1995/1996; Westfall 1997; Nie 1999), suggesting that telework is still a minority phenomenon. Nevertheless, surveys of teleworkers, of the general labor force, and evaluations of pilot teleworking studies provide some indications of the factors that motivate individual employees to telecommute, or that prevent them from doing so. Numerous data sources indicate that factors of gender, family life cycle stage, occupation and work style preference all affect the decision to telework. Length of commute appears to be another motivating factor, with pilot study data suggesting that teleworkers generally live farther from work (Handy & Mokhtarian 1996) — although it may be the case that the telework option influences that residential location.

A survey of almost 600 municipal employees in a southern California municipality found that both gender and occupation affected telecommuting motivations (Mokhtarian et al. 1998). Women were more likely than men to rate the telecommuting advantages highly. Family-related and stress reduction factors were more likely to motivate women than men. Women were less likely than men to express concern about constraints of supervisor reluctance, or lack of visibility to management. Occupation also influenced reasons for choosing the telecommuting option: clerical workers were more likely than professional/managerial workers to see as important the family, personal and stress-reduction benefits of telecommuting. Professional/managerial employees were more likely to cite the positive effect telecommuting would have on

productivity. Among the constraints cited, administrative and clerical workers were more likely to note possibilities for misunderstanding, supervisor unwillingness, unsuitability of a job, and reduced social interaction. Professional workers tended to agree on the reduced social interaction, and also noted fear of household distractions and lack of visibility to management. Respondents with children rated the stress reduction and family-related benefits of telecommuting more highly than did their childless colleagues. The presence of children also increased the chance that they would cite household distractions as a constraint.

A large body of research, including both employee surveys and program evaluations, indicate that non-work factors, particularly those relating to work/life balance, are a primary motivation for employees to opt for telework arrangements (Gurstein 1995,1996; Public Service Alliance Canada 1993; Statistics Canada 1995; Van Sell and Jacobs 1994). Many workers with family responsibilities experience difficulty balancing competing demands on their time. The telework option appeals as a way to balance these responsibilities and improve the quality of work and family life. Care for school-age children, including during times of illness, or care for elderly relatives is more easily arranged if work schedules are flexible. Telework is generally not considered a substitute for child care for pre-school age children — the difficulty of combining work and child care discourages many parents of young children from wanting home-based telework (Christensen, 1987, 1992). Non-work-related reasons may also motivate those without family obligations to telework. Freedom to schedule one's work activities permits a balance between work and leisure activities. One additional non-work related factor that motivates many to telework is the desire to improve quality of life by reducing time and stress of automobile commuting (PSAC 1993; Statistics Canada 1995).

Work-related factors also motivate some workers to telework. A Statistics Canada evaluation of a pilot telework project found that home-based teleworkers appreciated the lack of interruptions, noise, cramped office workspaces, and opportunities for better concentration. In the words of one teleworker, "With telework, I never kill time. I just log off when things are going bad instead of looking at the clock or socializing. When I'm ready to focus again, I log back on." (Statistics Canada 1995, p. 21).

Concerning teleworker compensation issues, two issues arise: wage rates and whether the employer or employee pays for equipment. An early British survey by Huws compared wages paid to home-based teleworkers ("new technology homeworkers") and their counterparts working comparable jobs in offices (Huws 1984). Huws found that the home-based computer teleworkers were paid "noticeably less, on average than their office-based counterparts" (Huws 1984, p. 46). This was despite teleworkers having to pay for their own equipment and utilities. In contrast, a 1995 Canadian survey of work arrangements compared pay rates for a large, national sample of workers whose main workplace was at-home against those working on an employer's premises (Péresse 1998). That survey covered all types of home-based workers. Using standardized data for age, sex and industry as well as standardizing for occupation, that study found that those working from home earned more per hour, although they enjoyed fewer benefits, compared to those working on an employer's premises.

A related question is whether some teleworkers would be prepared to work for less money than office workers. While some telework consultants advise teleworkers against settling for less (e.g., Gil Gordon

Associates 2000), there has been little investigation of the issue. A 1998 press release by Ekos Research Associates (1998) provided some evidence that a fair proportion of would-be teleworkers would take a 5 to 10% cut in pay in order to have the privilege of teleworking. Thus, it *may* be possible for employers to reduce personnel costs along with facility costs by the widespread adoption of telework. At this point, however, there is little evidence that this is happening, and some research (e.g., Bernardino 1996) suggests that productivity losses could ultimately occur if teleworkers were paid lower salaries. Clearly, there exists a need to examine relative pay levels in more detail and their associated impacts on productivity levels and the perceived advantages and disadvantages of telework.

Productivity

Employee productivity is crucial to the bottom line of any organization, and is central to the evaluation of any telework program. When productivity or other aspects of performance improve, this means that more and/or better results are being gained for a given amount of effort. Of course, the nature of results varies according to job tasks and responsibilities, and the challenge of defining and measuring employee output is not unique to teleworkers, but rather extends to most jobs that are not piece-work. The challenge can be especially acute for knowledge workers whose product is less tangible and for which metrics have not been established.

Fortunately, in some cases companies/managers have established formal evaluation criteria for assessing telework. For example, a study of American Express employees showed that teleworkers handled 26% more calls and produced 43% more business than their office-based counterparts (Canadian Telework Association 2000). Similarly, a 1991 study by duBrin on employees of a national market research firm showed that the average number of transactions per hour increased by 30%. Other times, supervisors measure productivity based on whether teleworking employees meet deadlines and work objectives (e.g., Statistics Canada 1994).

In most cases, however, productivity claims are not based on formal evaluations, but on subjective impressions of performance by the telecommuters themselves or their managers (for lists of studies see Belanger 1999; Westfall 1998; Rathbone 1992; or visit the Canadian Telework Association at www.ivc.ca or the International Telework Association & Council at www.telecommute.org). Virtually all of these studies report substantial gains in output typically in the range of 20 to 35%, and sometimes much higher. But the nature of the data raises questions about the validity of the estimates, and has led one prominent researcher, Ralph Westfall from University of Southern California, to conclude that:

“the evidence for productivity gains is not highly compelling. Many of the references are anecdotal reports of programs within organizations with no indication of the methodology or qualifications of the people who evaluated the results. Some of the examples come from within the telecommunications and computer industries, which have vested interests in reporting favorable results to telecommuting. Some of the increases cited ... are so large ... that they raise questions about the data” (Westfall 1998, p. 258).

Duxbury and Neufeld reach a similar conclusion noting that “while organizations who have implemented telework programs feel that such work arrangements have resulted in decreased costs and increased productivity, there is, as yet, very little hard data to back their claims” (Duxbury and Wenfeld 1992, p. 2).

One of the most problematic methodological issues in these subjective studies is the lack of a control group (i.e. employees who continue to work at the main office) against which to compare teleworkers’ perceived productivity gains. Consider, for example, the results of a study from a multi-year telecommuting demonstration project as reported by Nilles (Nilles 1998). The study was based on interviews and surveys with more than 300 telecommuters, their non-telecommuting co-workers and supervisors. The results indicate that telecommuters, on average, experienced a 30% increase in effectiveness over time. But the non-telecommuters also reported large increases in effectiveness over time. In fact the averages were so similar between the two groups that they were not statistically significant (at a 95% confidence level), i.e., the researchers could not be confident that there was a difference at all. Similarly, a Virginia-based study by Belanger indicates that the difference between teleworkers’ and non-teleworkers’ self-assessments of work performance was not statistically significant (Belanger 1999).

These studies suggest one of two things. Either telework is so powerful that it positively affects the performance of teleworkers as well as those who remain in the central office, or else one must interpret subjective assessments of productivity gains with caution. While the first explanation is possible because of spillover effects from teleworkers to office workers (e.g. due to higher morale or improved management practices), it is more likely that subjective assessments of telework, especially self-assessments, are inflated.

In addition to the problem of ascertaining numerical estimates of average productivity change, there are several other important issues related to productivity. These include the variable effects of telework on output, the tradeoff between output and costs, and the extent to which employees log longer hours in order to achieve higher output. Each of these will be discussed in turn.

First, the results of studies on teleworker output are not universally positive. Indeed, even in self-assessments there is a high degree of variability in perceptions from teleworker to teleworker and between teleworkers and others in the organization. In some cases, the vast majority of teleworkers report productivity gains. For example, at IBM, a survey of employees in the Mobility Initiative revealed that 87% of teleworkers believed that their personal productivity and effectiveness on the job increased significantly (Apgar 1998). The results are only slightly less positive in the 1998 national survey by the Kensington Technology Group and at AT&T (Canadian Telework Association 2000) where the proportion of teleworkers who reported increased productivity was approximately three-quarters and two-thirds, respectively.

However, other studies show much more internal variability. For example, the 1999 Telework America National Telework Survey (see Pratt 1999) found that only 47% experienced increased productivity, while 42% experienced no change and 10% thought that their productivity dropped. There is also evidence that self-assessments of productivity change tend to be more positive than assessments by either supervisors (Nilles 1998) or co-workers (Ekos 1998). For example, the results of the US West Survey (Miller and Self

2000) which asked people to rate the productivity of their organization's teleworkers versus other workers, were quite conservative with 31% responding "more productive," 56% responding "as productive," and 6% saying "less productive" (7% gave no answer). Thus telework seems to increase the performance of many, but universal and substantial productivity gains should not be assumed. In addition, immediate gains in productivity may not necessarily be sustained. Insufficient attention has been given to the transfer of tacit organizational knowledge and the establishment of organizational commitment in dispersed work settings, and the long-term implications of these for work team performance (Ellison 1999, Kurland and Bailey 1999).

Reasons for productivity gain are widely discussed (e.g., Froggatt 1999, Himmelsbach 1998, Nilles 1998; Perusse 1998; Huws et al. 1990). First, teleworking employees may have a clearer sense of expectations because of more outcomes-based management practices. Second, in many cases, there are fewer interruptions and less wasted time in a home-based or satellite office than in a corporate office. Third, employees can manage their time in a more optimal way, synchronizing their work schedule with times of peak performance. Fourth, employees can design/alter their workspace to whatever works best for them. Finally, some argue that because teleworkers have more work autonomy/control, they also assume more responsibility for accomplishing objectives. Reasons for productivity loss are less well understood, but may relate to the suitability of the employees, managers, or job tasks for remote work; the nature of telework arrangements; the extent to which teleworkers are trained and e-literate; as well as the characteristics of the home/satellite work environment.

In terms of economic analyses, there have been some attempts to translate productivity changes into dollar values. For example, the 1999 Telework America National Telework Survey (Pratt 1999) reported productivity gains equal to approximately \$1,850 per teleworker per year based on an average increase of 22% in self-reported productivity per day and factoring in average salary and telework frequency. Some other estimates are higher, but again Westfall argues that this is because productivity gains are likely overstated, which leads him to conclude that "to make telecommuting economically viable — it is essential to capture potential occupancy cost savings" (Westfall 1998, p. 284). In some organizations this is done, but in others office configurations and space needs are unchanged. Thus, there are likely some situations where telework is a sound financial investment and others where program costs outweigh productivity benefits.

The final productivity issue to be discussed pertains to hours of work. Most would agree that true productivity gains are reflected in higher output per hour, rather than higher daily/yearly output due to longer work hours. It is therefore important to consider hours of work. There is a trend amongst professionals in North America toward longer hours of work regardless of work place (e.g., Akyeamong 1997). There is also ample evidence that a large segment of the professional workforce takes work home, and that many are not paid specifically for this work (Deming 1994, Duxbury et al. 1992). This type of day extension is common for teleworkers. Teleworking employees tend to work long hours, well above the standard 35-hour workweek. For example, Pratt (1999) reports that 42% of American teleworkers work 50 to 75 hours per week, whereas evidence from a European survey shows that one-half of regular teleworkers work more than 10 hours per week extra, i.e. above the contracted number of hours (Empirica 1999).

On the other hand, there is very little evidence that teleworkers resent these hours; for example, work hours are seldom mentioned in surveys that asked teleworkers to report on disadvantages (Duxbury et al. 1998; Gurstein 1995; KPMG 1997) and studies that do raise work hours as an issue get mixed results. For example, a 1996 evaluation of the Treasury Board of Canada's telework pilot policy showed that approximately one in five teleworkers thought that longer hours of work were a problem associated with telework; but this same population of teleworkers believed that, on average, they had become somewhat better at completing work without overtime.

In summary, available data indicate that telework is normally associated with modest productivity gains on a per-employee basis, but that this is, in part, due to a longer work day/week.

Absenteeism and Retention

Among the many impacts of teleworking, considerable attention has been paid to employee retention and recruitment. For the most part, employers benefit by being able to offer flexible work arrangements that are attractive to many potential employees. Opportunities for telework also open the door to a larger recruitment pool of potential employees.

Supporting evidence for improved retention rates comes mostly from employee and employer surveys. For example, based on an informal qualitative survey, Rathbone (1992) reports that 6 of 16 organizations contacted in the U.S. (28 in total approached) noted improved retention rates, while the remainder noted that it was either the same, too early to say, or unknown (Rathbone 1992). In a similarly small-scale survey, 30 supervisors from 11 organizations in Massachusetts were asked to identify the single best benefit of telecommuting. Responses included improved employee retention/attraction along with a range of other benefits (improved employee morale, increased productivity, reduced costs due to space reductions, and flexibility). The improvement in morale is likely a strong contributor to the higher retention rates.

More recent larger scale studies provide more definitive results. For example, out of a sample of 205 Transportation Coordinators in Phoenix, just over one-third felt that telecommuting programs have helped with employee retention. In a subsequent survey of employer's reasons for allowing telecommuting, improved employee retention was cited by 11% of employers. Retention was overshadowed by the desire to improve productivity (28%), enable employees to balance work and personal life (25%), and stay in compliance with environmental regulations (25%). In the study conducted by Pratt, 53% of the 247 teleworkers randomly surveyed in the U.S. indicated it would be "important" or "extremely important" to have the ability to work at home some of the time when considering a new employer (only 15% of teleworkers indicated that the ability to work at home was "not at all" important to their employment consideration). Based on this figure, and the assumption that an employer saves on average one-third of the employee's salary in not having to replace them ($.33 \times \$44,000 = \$14,667$), Pratt estimates a $\$7,920 \times 54\%$ (\$14.667) costs saving per teleworker.

Nilles (1998) also confirms decreased turnover and associated reductions in personnel search, hiring and training costs (Nilles 1998). He discusses a survey of more than 300 teleworkers where 23% replied that they had seriously considered quitting, and most of these indicated that the ability to telecommute was a moderate to decisive influence on the decision to stay. He also indicates that the cost of replacement is at least 25% of an employee's annual salary.

A somewhat related issue to retention is that of absenteeism. It seems natural that an employee's ability to work at home should reduce absenteeism due to an enhanced flexibility to deal with common triggers for work absence such as family illnesses. Telecommute America also reported anecdotal information that inclement weather has less of a disruptive effect for telecommuters. The most comprehensive survey to date appears to that performed by Pratt for the International Telework Association and Council (ITAC). In total, 247 teleworkers and 1,242 non-teleworkers out of 26,667 randomly dialed households in the U.S. were contacted for the survey. Overall, employers reported that outside of personal illness, they are most often absent as a result of family and personal obligations during the business day (e.g., caregiving, doctor visits, after-school functions) resulting in an average of 45.3 occurrences (or 165.1 total hours) of absenteeism per year. However, because teleworkers are able to blend work and personal needs during the day, a majority of them (54%) indicated that they were still able to work the same or more hours on telework days despite managing personal and household matters. Perhaps most revealing was teleworkers' response to how they would manage personal needs if they *could not* telework, revealing an array of strategies including:

- Take personal leave (33%)
- Take sick leave (17%)
- Leave work early (14%)
- Have someone else do it (13%)
- Go to work late (11%)
- Leave, then return to work (9%)
- Take leave of absence (8%)

These results provide convincing evidence that telework significantly reduces absenteeism, even if just a portion of these possible outcomes is avoided. Taking matters further, the costs savings to employers were calculated using self-reported average salaries and the average number of days absent on which teleworkers are able to work from home. It was estimated that employers could save 63% of the cost of absenteeism per teleworker, or \$2,086 per teleworker per year. Although this estimate may be biased due to the small response rate, the approach is well justified given the careful attention to the types of absences and proportion of absent time that could reasonably be made up in the home.

In contrast, public sector unions may have a different perspective on the issue of reducing absenteeism through telework. For example, the Public Service Alliance of Canada (1993, 1996) warns of the need to consider health and safety hazards of the home workplace, and the need to protect sick leave for all work-

ers. Possible negative impacts such as these should be given careful consideration despite any overall positive gains.

Equity

The emergence of telecommunications, and especially “virtual call centers,” holds promise of enhancing the appeal of telework for disabled workers, caregivers, the elderly, and rural residents. This is especially so for those people without access or ability to drive automobiles. In virtual call centers remotely-based workers can be managed as if they were in close proximity. As part of a larger study of UK teleworkers, Huws and Denbigh (1999) conducted case studies of a number of virtual call centers, considering their potential to create employment opportunities for persons who are disadvantaged in the labor market for reasons of disability, because of caregiving responsibilities, or because they live in remote rural areas. They identify both a strong potential demand for virtual call center work, and a supply of appropriately skilled labor. They caution, however, of the need to provide appropriate training, team-building and support for remote teleworkers and address issues of quality of work life (including health and safety issues, contractual issues, and benefits and expenses).

For physically disabled persons in particular, telework appears to be a natural approach to increasing employment possibilities. However, there are several important challenges. First, surveys of disabled workers (e.g. Pratt 1984) revealed that disabled workers find long hours at a terminal to be physically difficult and socially isolating. Second, Huws et al. (1990) cautions that disabled workers need sociability as much as income, suggesting that neighborhood telework centers would be preferable to home-based telework (Huws et al. 1990). Furthermore, the Public Service Alliance of Canada (1993) warned that increasing home-based telework for persons with disabilities might reduce pressure to make workplaces accessible.

The issue of gender and equal access to flexible work arrangements is another sensitive issue. Females are more likely than males to hold clerical positions that may be less likely to be considered appropriate for telework compared to professional positions (Bélanger 1999). Recent research by Brewer (2000) examining adoption of telework and other types of flexible work scheduling in Australia found evidence of a two-tiered labor market in which jobs typically filled by males were more likely to permit telework. Brewer’s analysis of a large survey of the Australian workforce examined workers’ experience with and attitudes toward flexible work arrangements, including telework. Only 6.6% of the 1,200 workers surveyed reported that their employers supported telecommuting. Men were more likely than women to work in companies that supported flexible work arrangements. Professional and managerial occupational categories—more likely to be filled by males — were more likely than predominantly female service, sales, clerical and administrative categories to be considered suitable for flexible work arrangements.

One additional equity issue concerns the selection process of employees for telework opportunities. This is a particularly sensitive issue in light of the popular appeal of this type of work arrangement (Johnson 1995; Public Service Alliance of Canada 1996). Teleworkers involved in focus groups as part of a Statistics Canada (1995) pilot project identified the potential for abuse by supervisors in the selection process. In-

volved supervisors agreed that the process was ill-defined and observed that it might appear discriminatory with the potential to result in employee grievances.

Indirect Impacts

There are wide ranges of possible short and long-term organizational, individual and societal impacts of telework. This section reviews those impacts that are not directly measured in economic terms but have an indirect effect on regional and national economies.

Transportation Impacts

At an individual and community level, the transportation implications of telework are of paramount importance. Travel choices have serious implications for household and government budgets both in terms of direct expenditures and indirect health costs. There is general consensus in the literature that telework is associated with travel modifications, but there is ongoing debate about the nature and extent of these changes. The most contentious issue is the validity of the substitution hypothesis, which asserts that telework substitutes for travel, resulting in a net reduction of auto trips/miles. There are both theoretical and empirical reasons for the debate. First, while telework may replace the traditional journey to work, complementarity or synergism between existing transport systems and tele-technology may induce travel replacement travel by either the teleworkers themselves or other drivers.

Most empirical studies on the interactions of telecommunications and travel focus on work-related travel of regular telecommuters, i.e., those employees who spend at least one whole day per week working at home or a satellite office. There have been many such studies, due in large part to the work by Patricia Mokhtarian and her research colleagues (e.g., see list in Golob 2000). Thus the direction of the effect is now clear: “Among micro-scale application-specific studies, evaluations of telecommuting unanimously observe net substitution” (Mokhtarian 2000, p. 3), i.e., work-related driving, and sometimes total automobile travel, are reduced for telecommuters. This occurs despite the fact that most telecommuters do not change their usual travel modes.

But the magnitude of the effect is far from clear. Results vary from study to study, and our understanding of the ways in which telecommuting releases latent travel demand, both within the telecommuting household and in society more broadly — is still very much in its infancy. As a result, it would be unwise to translate telecommuters’ work-travel reductions into relief of traffic congestion.

Telework may also have long term impacts on auto-mobility through residential re-location and the associated reshaping of spatial form. With regard to re-location the major concern is that telework will result in further decentralization/sprawl, which has serious financial implications — because of direct costs associated with municipal infrastructure provision and indirect costs associated with the loss of high-quality farmland and increased travel/vehicle emissions.

At this point, however, the empirical evidence addressing this issue is both scant and mixed. The low quantity of evidence is due in part to the relatively small proportion of teleworkers in the workforce, but it is also a reflection of the types of studies that have been completed. Most studies have focused on new telework programs and short-term effects. Not surprising, then, most participants in these studies report either that they have not re-located or that telework did not play a role in their re-location decisions (e.g., Nilles 1991). There is clearly a need for more panel/longitudinal studies that track household adaptations to new work forms over an extended period of time (e.g., Golob 2000; Mokhtarian 2000).

In terms of the evidence being mixed, on the one hand, several authors have noted the emergence of electronic cottages in resort towns and rural areas — areas with mild climates, charm and/or other environmental amenities as well as easy access to an airport or major highway (e.g., Leinberger 1994). Mokhtarian notes that “anecdotal evidence suggests that “lone eagle” professionals and “high flyer” small-scale employers are moving into rural communities in numbers large enough to affect real estate markets and alter the character of the communities” (Mokhtarian 2000, p. 6). Other research, however, suggest that there are both centripetal and centrifugal forces at work, with some teleworkers showing/stating a preference for living closer to the city center and others preferring to move outward (e.g., Gurstein 1995). On the whole, we simply do not know enough about the complex interrelationships between telecommunications and spatial activities to make reliable predictions or assessments.

Work-Life Balance

Much attention has been paid to the impact of telework on the “Work-Life,” “Work-Family,” “Work-Home” or “Work-Community” balance. When the workplace is moved into the home environment, it is argued that there is the dual potential to exacerbate conflict, or to minimize it through increasing work schedule flexibility. Mills defines this work-family conflict as “the interrole conflict that can be experienced by an individual when the role pressures from the employment and family domains are incompatible or conflicting” (Mills et al. 2000, p. 139). Duxbury highlights this duality in their paper titled “Is telework part of the problem or part of the solution?” (Duxbury et al. 1998, p. 218).

Empirical research has thus supported a view of telework variously as a contributor to, and potential solution for, the stress of competing demands of work and personal/family life. Some studies and reviews of the literature have concluded that telework introduces flexibility for employed parents, reducing workers’ role overload and thereby supporting family life (Higgins et al. 1992; Huws et al. 1990; Duxbury et al. 1998; Pratt 1999; Van Sell and Jacobs 1994). Others, however, have found home-based telework to be stressful due to the co-location of paid employment and family responsibilities, contributing to role interference and overload (Duxbury et al. 1996; Bulos & Chaker 1993). Other negative effects include lack of flexibility due to others’ schedules, an extended workday/week of work-at-home (Allen and Wolkowitz 1987; Christensen 1988; Michelson et al. 1998), and extended work hours (Pratt 1999; Public Service Alliance of Canada 1993). In addition, Rowe and Bentley (1992 as cited in Mills et al. 2000) found that male home-workers were less likely than females to report carrying out their employment and family responsibilities simultaneously, and were also less likely to have to adapt to family interruptions of their work activities.

Thus, the gains in flexibility to balance work and life associated with telework appear to be mitigated by longer work hours and possible role overload effects. The net effects of these factors are still relatively unclear, and are probably best assessed on an individual basis. For instance, the teleworkers involved in the Statistics Canada (1995) pilot project felt that telework had a favorable effect on home life and the lives of other family members and denied that the work arrangement increased the net amount of time they spent on family-related activities.

In terms of community involvement, moving the workplace into the home may affect the nature of life in local residential neighborhoods. Instead of being bedroom communities, vacant during the workday, local neighborhoods may be characterized by increased levels of social interaction. The combination of flexible hours and home workplaces may mean that teleworkers increase their use of neighborhood-based services. While these are possible impacts, there is relatively little research data documenting such changed patterns. Gurstein's 1995 national survey of Canadian home-based workers, including teleworkers, found little indication of increased neighborhood contacts and activities among home-based workers.

Home Work Space

A number of issues arise when the workplace is physically moved into the home. These include: effectiveness and adequacy of the home environment as workspace, impacts on home for teleworker and family members, and effect of gender on experience of their home as workspace.

While many teleworkers may be satisfied with their home workspace, very few have defined office areas. For instance, over one-quarter of teleworkers involved in a Statistics Canada (1995) pilot project had no defined office area in the home for work, and instead worked in a corner of a room or "anywhere they could find a comfortable spot." Similarly, most teleworkers in Britain had "limited space to undertake teleworking activities" (BT Laboratories 1992; Department of Trade and Industry 1998 as cited in Green et al. 2000, p. 306). Green also cite results of a 1999 internet survey in Britain that found that between one-quarter and one-third of home-based teleworkers reported not having a dedicated room for telework, but instead had to create space within a room used for other purposes (Green et al. 2000). In the U.S., Ahrentzen (1990, 1997) interviewed approximately 100 U.S. homeworkers to probe the ways they integrate employment activities into the home, and whether the home workspace affects feelings about the home as a refuge. She found that, rather than experiencing the home in its entirety, those with a home workspace tended to differentiate the home into various areas, some more public, others more private.

Overall, it appears that the availability of physical workspace at home is an important dimension in telework performance. Gurstein observed that in order to be successful, it is necessary for teleworkers to "have an organized workspace with clear boundaries between work and household spaces" (Gurstein 1996, p. 218). While there are some who would reinvent the home to create an environment better suited to teleworking, according to Huws purpose-built housing for teleworkers is likely to be the exception for many years to come (Huws et al. 1990). In the short term, they recommend changes to existing housing stock to better support telework, allowing it to take place in "secure, congenial, uninterrupted and ergonomically appropriate conditions" (Huws et al. 1990, p. 212).

Measurement Challenges

While qualitatively, the range and approximate magnitude of economic impacts such as productivity, wages rates, absenteeism and retention rates has been well researched (mostly through surveys), quantitative estimates/forecasts of specific economic impacts of telework have been sparse. Even when estimated economic savings have been projected due to factors such as decreased absenteeism and improved employer retention (e.g., the logic of the calculations is not well explained and it is relatively unclear whether the savings are one time or per year savings. Part of the challenge of such measurement is the lack of formal methods of reviewing or monitoring telecommuting program success . The fact that many different “players” exist in the administration and success of telecommuting programs, combined with the wide range of possible organizational, individual and societal impacts in the short and long term, presents further challenges to comprehensive measurement and assessment.

In response, comprehensive attempts to address these issues have adopted a multi-actor and/or multi-instrument approach to data collection. Early studies recognized the need to investigate both employees and employers to understand the impacts of telework, including effects on hours at work, tasks, supervision, communication, and nonwork impacts such as leisure activities, family responsibilities, and community activities. The combined importance of measuring both employee and employer preferences is also highlighted by Brewer and Hensher who developed an “interactive agency choice experiment.” Whereas typical discrete choice and stated preference surveys focus on an individual’s choice their experiment involved the determination of cooperative choice probabilities associated with the adoption of telecommuting options. The analysis of each step in the choice experiment is represented as a recursive process in which the prior agent’s choice conditions the subsequent agent’s choice. Results of their experiment highlight differences in the way employers and employees view the impacts of telecommuting — confirming for the most part that employers typically assess impacts in terms of what is good for the organization, whereas employees assess impacts in terms of “what’s in it for them” from a work and personal life perspective.

Other recent studies have tackled the measurement challenge through combined multi-actor and multi-instrument designs. For instance, WestGroup Research assessed a broad range of telecommuting topics (including awareness, attitudes and business practices) by surveying community leaders, transportation coordinators, employers, and employees using phone surveys and focus groups. Even more extensively, Boyd et al. recruited separate samples of telecommuters (n=281), non-telecommuters (n=150; control group), supervisors (n=30), and organizational leaders (n=41; HR administrators, telecommuting coordinators) from 50 organizations in Massachusetts to complete the following sequence of survey instruments:

- Initial Mail-Out Survey (all) — work habits, quality of work-life, attitudes;
- Supervisor’s Survey (supervisors only) — teleworker performance and management;
- 3-day Summer Travel Logs (all) — to assess transportation impacts;
- 3-day Winter Travel Logs (all) — same as above;
- Follow-up Telephone Survey (all) — similar to initial survey; and

- Organizational Telephone Interview — program types, supervisory concerns.

A similar approach has been adopted for an on-going project by Mokhtarian et al. at the University of California, Davis (see Mokhtarian 1996a). The project seeks to evaluate the impacts of telecenters on work performance, job satisfaction and travel behavior using four survey instruments: an attitudinal survey, a travel diary, an attendance log, and an exit interview.

A related issue in the attempt to more quantitatively assess economic impacts is the use of “control groups.” In experimental designs, control groups provide a comparison group and/or are used to account for general increases/decreases in specific indicators over time not attributable to the experimental effect. Examples of effective use of control groups include: Niles who compared a sample of 400 teleworkers travel patterns to a control group of non-teleworkers; Boyd who utilized a control groups in order facilitate identification of differences in attitudes and perceptions of telecommuters versus non-telecommuters; and Bélanger who compared 38 telecommuters to 34 non-telecommuters concerning their choice of whether to telecommute.

An over-riding measurement challenge facing impact studies that use surveys is the issue of sample representativeness. Mokhtarian and Salomon 1996 highlight the importance of self-selection bias associated with telecommuter surveys — i.e., that people most likely to respond to surveys are frustrated in their desire to or not to telecommute or are telecommuters already and are thus interested in the subject. Under-representation of those with no interest in telecommuting is likely for most surveys. Sample representativeness is also an issue for many research studies based on samples drawn from limited industry types, job types (e.g., professionals), or from only a small selection of possible companies, especially information technology companies (e.g., Bélanger 1999). Obviously, expanding such samples is required to make generalizations concerning any type of impact on the economy as a whole. Low response rates for surveys are also a key issue in terms of representativeness. For instance, little mention is made of the rather low response rate of 5.6% in the 1999 Telework America National Telework Survey (Pratt reports that 247 teleworkers and 1,242 non-teleworkers out of 26,667 randomly dialed households in the U.S. responded). Despite this, the results have been very well publicized by the sponsoring organization International Telework Association and Council 1999) and have received attention in the press (e.g., Hrisak 1999).

Several authors have also emphasized the need to standardize definitions associated with teleworking (e.g., Handy and Mokhtarian 1996; Pratt 2000). Pratt argues that accurate forecasting of the impacts of telecommuting must start with appropriate definitions of work in terms of location, tasks performed, time worked and days worked at home versus at the employer’s location. This is especially important since the amount and type of telework varies considerably, and is rarely full-time. For similar reasons, Handy and Mokhtarian argue for a distinction in measurement between *telecommuting occasions* and *telecommuters* and for consistently applied approach to defining and identifying telecommuters. Clearly, the current and future impacts of telecommuting, including productivity, absenteeism, and indirect social impacts will depend to a large degree on the accuracy to which the quantity and quality of telecommuting is measured.

It is most likely that telework will expand in the near future as a “necessary component of the evolving structure of modern work essential for helping employees better balance work and home life.” This, com-

combined with the widespread recognition and evidence in support of net economic gains, suggests that the time is right to *go beyond measurement of observed impacts towards a greater understanding of how people achieve such gains*. There appears to be wide-scale recognition that telework allows employees an opportunity to better “manage” their work and personal life, and that this leads to significant economic gains related to increased productivity, retention and reduced absenteeism. While outwardly these effects are becoming much clearer and evidence is growing, the underlying mechanisms through which employees achieve these gains has remained relatively unstudied and unmeasured — i.e., the question of “how.” Phrases such as “Managing,” “Handling,” “Restructuring,” and “Blending” of work and personal life are often used to describe the process through which teleworkers achieve economic gains, but few have investigated the underlying fundamentals. What does seem clear is that the impacts of telework are mitigated by a “decision process” that occurs within organizations and households. This decision process involves the managing, scheduling, adaptation and execution of economic “activity” within firms and households over time and space. Enhanced flexibility to *schedule* and *reschedule* one’s work and personal activities to different times and/or locations to avoid absenteeism and be more productive appears to be the key factor.

Investigating this underlying “scheduling” decision process, combined with observing outward impact on work tasks and personal activities, would provide an enhanced opportunity to quantify the economic impacts and understand the mechanism people adopt to achieve the gains. In the least, such an approach would help to identify good management/scheduling techniques to assist future teleworkers and employers. However, such an approach would also help identify possible (negative) secondary and long term impacts of telework such as the effect of rescheduling activities and travel into the evening or weekends, added burden on supervisors, distribution of scheduling burden across household members, prolonged work hours at home, etc. Observing such behavior over an extended period within organizations and households would appear to be the key challenge, given that telework impacts involve rescheduling over time and across individuals.

Perhaps even more importantly, understanding underlying behavioral mechanisms that control observed responses would assist in the forecasting of the impacts associated with new telecommuting technologies and/or telework arrangements (e.g., software to support virtual team work, improved speed of data transmission). This is especially important since such technologies are rapidly changing, essentially making teleworkers “moving targets” of observation.

Utilization of multi-disciplinary research approaches is needed to address such issues. Concepts derived from space-time geography, especially the notion of space-time prisms as introduced by Hägerstrand (1970), and related emerging approach that focus on activity scheduling behavior (e.g., Axhausen and Garling 1992; Ettema and Timmermans 1997) would appear to offer promise. Observing how teleworkers make decisions using cognitive or sociological techniques would also be valuable. For instance, Norman et al. (1995) and Konradt et al. (2000) examined how teleworkers deal with work-related problems and stress, while Mirchandani (1999) used open-ended qualitative interviews and focus groups to investigate the daily decision making of teleworkers. Alternatively, from the field of economics, the application of “Agency Theory” to teleworkers appears to offer promise in understanding how and why teleworkers might deal with a revised supervisory situation. Linking such research to quantitative measures of economic impacts would provide a very comprehensive approach to assessing *and* understanding the impacts.

An underlying measurement challenge associated with assessing telework impacts is the identification of possible long-term negative impacts. A thorough review of the types of possible organizational, individual and social advantages *and* disadvantages of telework is provided in Kurland and Bailey (1999). Early on, Salomon and Salomon (1984) highlighted the possible loss of social interaction at work due to working at home, and the need to separate home and work roles. More recently, Gainey et al. warns that “the advantages attributed to telecommuting may lure company leaders to rapidly accept this alternative without adequately considering the long-term implications of isolating workers from the traditional office setting.” From a land-use/transportation perspective, Snider warns that teleworking facilitated through the expansion of the information highway may spread urban growth much farther out into rural hinterlands just as interstate highways did in the 1950s and 1960s, eclipsing any positive impact telework has on reducing travel to work. For the most part, there is very little clear evidence of persistent negative consequences such as isolation and urban sprawl, and such issues tend to take a back seat to the more obvious positive impacts. Mokhtarian reminds us that telecommunication, like other new technologies, is accompanied by a lot of hype and over optimistic selling of positive impacts, and that we need to “peel away the exaggeration and find the reality underneath” (Mokhtarian 1996b, p. 24). She emphasizes that such technologies may solve some problems while creating others.

Overall, these warning and current research trends should help encourage the adoption of measurement frameworks for assessing telework that:

- balance queries concerning positive *and* negative impacts, and opposing viewpoints;
- encourage adoption of longer-term observation period of teleworkers and employers in an effort to identify diminishing gains and/or emerging problems;
- measure the impacts of telework in context of longer-term changes in land-use (e.g., residential choice), and transportation that it may provoke;
- focus on quantifying economic impacts and cost savings for both employees and employers beyond self-reports from surveys (e.g., comparisons of employee turn-over rates, absenteeism and wage rates for similar companies with and without telework programs); and
- address underlying behavioral response mechanisms adopted by employers and employees in order to provide suggestions for effective teleworkers management/scheduling techniques for training purposes, improve forecasts of impacts of fast emerging technologies, and identify short and long-term secondary impacts.

Summary and Conclusions

With reference to the original themes of this paper, this literature review offers several conclusions and identifies possible new directions.

In terms of typical teleworker tasks, most of today’s teleworkers are in the professions — performing tasks such as thinking/planning, reading/writing and research — and many hold fairly senior positions.

However, there is a growing trend for clerical, administrative and technical staff to telework on a part-time and or after hours basis. In most cases, regardless of the job level or responsibilities, there is a high reliance on computers and telephones.

The main motivations for deciding to telework include non-work factors, especially those relating to work/life balance (personal and stress benefits), and work-related factors such occupation type and work style. In particular, those seeking to reduce interruptions, or who hold professional/managerial positions are more likely to be motivated to telework. Gender differences in motivations to telework are also evident, especially as they relate to caregiving in the home. In terms of wage issues, results are mixed as to whether teleworkers earn more or less than their office counterparts. There has also been little investigation concerning whether would-be teleworkers would be willing to accept lower wages for the privilege of teleworking. There exists a clear need to examine relative pay levels in more detail and their associated impacts on productivity levels and the perceived advantages and disadvantages of telework.

In terms of employee productivity, concrete data often do not exist or are not in the public realm. Thus, it is difficult to ascertain with any precision the productivity implications of telework. Having said this, subjective evaluations are nearly unanimous in suggesting at least modest productivity gains on average. An important future challenge is to deepen our understanding of when and why productivity gains do or do not materialize.

In the opinion of most employers and employees, telework does reduce absenteeism and improve retention rates. While some estimates of actual costs savings have been produced based on self-reports, further confirmation is needed using more objective measures, such as the comparison of employee turnover and absenteeism rates for companies with and without telework programs.

Particular groups that may benefit from obtaining and retaining employment as a result of telework include disabled workers, caregivers, and rural residents. However, there exists a general lack of quantitative assessment of the actual benefits and opportunities created for such groups by new work forms, including telework. It is important that such assessments also consider potential negative consequences specific to these groups, such as the possibility of further isolating the disabled.

In terms of indirect impacts, virtually all empirical studies confirm that teleworkers have less work-related travel, but it is unclear whether this will have any real effect on traffic levels because of replacement travel by either the teleworkers themselves, their household members or other potential drivers in society. Our understanding of the complementarities between transportation and telecommunications is still very much in its infancy.

Measuring the economic impacts of telework has met with considerable challenge. While qualitative assessments of the impacts have been extensively studied, very few quantitative assessments of actual impacts exist (i.e., dollar equivalents). Multi-actor and/or multi-instrument research designs with more representative samples, investigation of underlying behavioral mechanisms, and use of control groups are key future considerations. Possible negative impacts in the long term should also be more seriously considered, as they have been somewhat overshadowed by recent emphasis on positive impacts. Multi-disciplin-

ary approaches from geography, economics, psychology, and sociology could all support these goals – the challenge is to bring them into a comprehensive framework addressing economic and social impacts.

Acknowledgements

The authors owe a debt of gratitude to Kelly Foisy for research assistance on this project, which was the beneficiary of her tireless ability to track down materials from remote and sometimes elusive sources. In addition, we wish to thank Professor Doug Kruse for his insightful and helpful critique of an earlier draft of this paper.

Endnotes

Given that operational definitions for the term “telework” vary considerably from study to study (Ellison 1999), as a point of clarification, the following working definition is used in this paper: Telework is broadly defined as employer-paid work activity conducted at a location other than the corporate office and facilitated by telecommunication technologies. It thus excludes home-based entrepreneurs and independent contractors. It includes both those who substitute travel to their usual place of work during the normal work hours in order to work at home or another location, as well as those who take work home after hours, but our primary focus is on the former group.

References

S. Ahrentzen, “Managing Conflict By Managing Boundaries: How Professional Homeworkers Cope With Multiple Roles at Home,” *Environment and Behavior*, 22 (6), 1990, pp. 723-752.

S. Ahrentzen, “The Meaning of Home Workplaces for Women,” *Thresholds in Feminist Geography*, John Paul Jones III, Heidi J. Nast and Susan M. Roberts (eds.), Lanham, Maryland, Rowman and Littlefield Publishers, 1997, pp. 77-92.

E.B. Akyeampong, “Work Arrangements: 1995 Overview,” *Statistics Canada Catalogue*, 75-001-XPE, 1997.

M. Apgar, “The Alternative Workplace: Changing Where and How People Work,” *Harvard Business Review*, May-June, 1998, pp. 121-123.

K.W. Axhausen and T. Gärling, “Activity-Based Approaches to Travel Analysis: Conceptual Frameworks, Models, and Research Problems,” *Transport Reviews*, 12(4), 1992, pp. 323-341.

F. Bélanger, “Worker’s Propensity to Telecommuter: An Empirical Study,” *Information and Management*, 35, 1999, pp. 139-153.

A. Bernardino, *Telecommuting*, New York, Garland Publishing Inc., 1996.

A. Bernardino, M. Ben-Akiva, and I. Salomon, "Stated Preference Approach to Modeling the Adoption of Telecommuting," *Transportation Research Record* 1413, 1993, pp. 22-30.

P.C. Boyd, D. Tringali, and M. Palladino, *Summary Report of Findings for the Massachusetts Telecommuting Initiative*, Boston, University of Massachusetts Donahue Institute/The Massachusetts Division of Energy Resources/Bureau of Transportation Planning and Development, 1996, p. 24.

A.M. Brewer, "Work Design for Flexible Work Scheduling: Barriers and Gender Implications," *Gender, Work and Organization*, 7(1), 2000, pp. 33-44.

A.M. Brewer and D.A. Hensher, "Distributed Work and Travel Behavior: The Dynamics of Interactive Agency Choices Between Employer and Employees," *Transportation*, 27, 2000, pp. 117-148.

BT Laboratories, *A Study of Homeworking Environments*, British Telecommunications, London, 1992.

Canadian Telework Association, Telework. www.ivc.ca. Ottawa, Canada, 2000.

O. Caso, "Spatial Impact of Telematic Applications in Residential Areas," in *A Future of Telework: Towards a New Urban Planning Concept?*, Fons van Reisen and Mart Tacken (eds.) Netherlands Geographical Studies 189. Utrecht: Delft University of Technology, Faculty of Architecture, 1995, pp. 153-167.

K.E. Christensen, "Managing Invisible Employees: How to Meet the Telecommuting Challenge," *Human Relations Today*, 19, 1992, pp. 133-143.

K.E. Christensen, "Impacts of Computer-Mediated Home-Based Work on Women and Their Families," *Office: Technology and People*, 3, 1987, pp. 211-230.

J. Cornford, R. Richardson, and A. Gillespie, *In Search of the Electronic Cottage?*, Centre for Urban and Regional Development Studies, University of Newcastle Upon Tyne, 1997.

W.G. Deming, "Work at Home: Data from the CPS," *Monthly Labor Review*, February 1994, pp. 14-20.

Department of Trade and Industry, *Working Anywhere: Exploring Telework for Individuals and Organisations*, Information Society Initiative, London, 1998.

DuBrin, "Comparison of the Job Satisfaction and Productivity of Telecommuters Versus In-House Employees: A Research Note on Work in Progress," *Psychological Reports*, 68, 1991, pp. 1223-1234.

L. Duxbury and D. Neufeld, "An Empirical Evaluation of the Impacts of Telecommuting on Intra-Organizational Communication," *Journal of Engineering and Technological Management* 16, 199, pp. 1-28.

L.E. Duxbury, C.A. Higgins, and S. Mills, "After-Hours Telecommuting and Work-Family Conflict: A Comparative Analysis," *Information Systems Research* 3(2), 1992, pp. 173-190.

Ekos Research Associates Inc., *Canadians and Telework*, Press Release, November 4, 1998, (available at www.ekos.ca/nov98.HTM).

N.B. Ellison, "Social Impacts: New Perspectives on Telework," *Social Sciences Computer Review*, 17(3), 1999, pp. 338-356.

Empirica GmbH Consultancy, *ECaTT (Electronic Commerce and Telework Trend) Survey*, (also available at www.ecatt.com/ecatt/surveys/results/nwwg90001.html), 1999.

D. Ettema and H. Timmermans, "Theories and Models of Activity Patterns," *Activity-Based Approaches to Travel Analysis*, D. Ettema and H. Timmermans. Oxford, Pergamon, 1997, pp. 1-36.

Ferrara Contreras Architects Inc., *Home Occupation Scenarios*, Ottawa, Ontario: Affordability and Choice Today Program, October 1995.

C. Froggatt, *New Work Directions: Creative Environments for the Future*, Gil Gordon Associates, (available at www.gilgordon.com), 1999.

T.W. Gainey, D.E. Kelley and J.A. Hill, "Telecommuting's Impact on Corporate Culture and Individual Workers: Examining the Effect of Employee Isolation," *SAM Advanced Management Journal*, 64(4), 1999, pp. 4-10.

Gil Gordon Associates, *Financial Issues of Telecommuting FAQ Telecommuting Tools*, (also available at www.gilgordon.com/telecommuting/faq.htm), 2000.

T. Golob, *TravelBehavior.Com: Activity Approaches to Modeling the Effects of Information Technology on Personal Travel Behavior*, Resource paper for the 9th International Association for Travel Behavior Research Conference, Gold Coast, Queensland, Australia, July 2-7, 2000.

H. Green, A. Strange, and H. Trache, "The Homeworking Revolutions: Considering the Property Dimension," *Regional Studies*, 34(3), 2000, pp. 303-307.

Y.P. Gupta, J. Karima, and T.M. Somers, "A Study on the Usage of Computer and Communication Technologies for Telecommuting," *IEEE Transactions on Engineering Management* 47(1), 2000, pp. 26-38.

P. Gurstein, *Planning for Telework and Home-based Employment: A Canadian Survey on Integrating Work Into Residential Environments*, Ottawa, Ontario, Canada Mortgage and Housing Corporation, 1995.

P. Gurstein, "Planning for Telework and Home-Based Employment: Reconsidering the Home/Work Separation," *Journal of Planning Education and Research*, 15, 1996, pp. 212-224.

T. Hägerstrand, "What About People in Regional Science?," *Papers of the Regional Science Association*, 24, 1970, pp. 7-21.

S.L. Handy and P.L. Mokhtarian, "Planning for Telecommuting: Measurement and Policy Issues," *Journal of the American Planning Association*, 61(1), 1995, pp. 99-111.

S.L. Handy and P.L. Mokhtarian, "Forecasting Telecommuting: An Exploration of Methodologies and Research Needs," *Transportation*, 23, 1996, pp.163-190.

S.L. Handy and P.L. Mokhtarian, "The Future of Telecommuting," *Futures*, 28, 1996, pp. 227-240.

V. Himmelsbach, "Working at Home Given Top Marks by Employees," *Computing Canada* 24(47), 1998, p. D29.

D.M. Hrisak, "Millions Move to the Home Office," *Strategic Finance*, 81(6), 1999, pp. 54-57.

U. Huws, *The New Homeworkers: New Technology and the Changing Location of White-Collar Work*, London: Low Pay Unit, 1984.

U. Huws, W.B. Korte, and S. Robinson, *Telework: Towards the Elusive Office*, Chicester, UK and New York: Wiley, 1990.

International Telework Association and Council, Press Release: *Employers Save \$10,000 Per Teleworker in Reduced Absenteeism and Retention Costs*, Washington, D.C., 1999.

L.C. Johnson, *Changing Families, Changing Workplaces: Case Studies of Policies and Programs in Canadian Workplaces*, Ottawa: Human Resources Development Canada, 1995.

Kensington Technology Group, *The Workplace Turns to Telecommuting to Drive Productivity*, Product News Releases, (also available at www.kensington.com), 2000.

U. Konradt, R. Schmook, A. Wilm, and G. Hertel, "Health Circles for Teleworkers: Selective Results on Stress, Strain and Coping Styles," *Health and Education Research: Theory and Practice* 15(3), 2000, pp. 327-338.

KPMG Consulting, *1997 Telecommuting Survey*, Toronto: KPMG, 1997.

N.B. Kurland and D.E. Bailey, "The Advantages and Challenges of Working Here, There, Anywhere, and Anytime," *Organizational Dynamics*, Autumn 1999, pp. 53-68.

C.B. Leinberger, "Flexexecutives: Redefining the American Dream," *Urban Land*, August, 1994, pp. 51-54.

LINK Resources Corporation, *Home Office Overview*, Report No. 0322, 1991.

J. Miller and R. Self, *Telework Enters the Mainstream: New Technologies, Social and Business Dynamics Transforming the Workplace*, Centre for Digital Culture (also available at www.ivc.ca/definit/on.htm), 2000.

R.S.L. Mills, K.A. Duncan, and J.J. Amyot, "Home-Based Employment and Work-Family Conflict: A Canadian Study," in *Gender and Home-Based Employment*, C. B. Hennon, S. Loker, and R. Walker (eds.), Westport, Connecticut: Auburn House, 2000, pp. 137-165.

K. Mirchandani, "Legitimizing Work: Telework and the Gendered Reification of the Work-Non-Work Dichotomy," *The Canadian Review of Sociology and Anthropology* 36(1), 1999, pp. 87-107.

P.L. Mokhtarian, *Residential Area-Based Offices Project: Interim Findings Report on the Evaluation of Impacts*, Institute of Transport Studies, University of California Davis, 1996a, <http://www.engr.ucdavis.edu/~its/tcenters/repts/Title.htm>.

P.L. Mokhtarian, "The Information Highway: Just Because We're on It Doesn't Mean We Know Where We're Going," *World Transport Policy and Practice* 2, 1996b, pp. 24-28.

P.L. Mokhtarian, "Telecommunications and Travel," in *Transportation in the New Millennium: State of the Art and Future Directions; Perspectives from TRB Standing Committees*. Washington, D.C., National Research Council, 2000.

P.L. Mokhtarian and I. Salomon, "Modeling the Choice of Telecommuting: 2. A Case of the Preferred Impossible Alternative," *Environment and Planning A* 28, 1996, pp. 1859-1876.

P.L. Mokhtarian, M.N. Bagley, and I. Salomon, "The Impact of Gender, Occupation, and Presence of Children on Telecommuting Motivations and Constraints," *Journal of the American Society for Information Science* 49(12), 1998, pp. 1115-1134.

N. Nie, "Tracking Our Techno-Future," *American Demographics*, 21(7), 1999, pp.50-52.

J.M. Nilles, "Telecommuting and Urban Sprawl: Mitigator or Inciter?," *Transportation*, 18, 1991, pp. 411-432.

J.M. Nilles, "What Does Telework *Really* Do To Us?," *World Transport Policy and Practice* 2, 1996, pp. 15-23.

J.M. Nilles, *Managing Telework: Strategies for Managing the Virtual Workforce*, New York, John Wiley & Sons, 1998.

P. Norman, S. Collins, M. Conner, R. Martin, and J. Rance. "Attributions, Cognitions, and Coping Styles: Teleworkers' Reactions to Work-Related Problems," *Journal of Applied Social Psychology* 25(2), 1995, 117-128.

M.H. Olson and S.B. Primps, "Working at Home With Computers: Work and Nonwork Issues," *Journal of Social Issues*, 40(3), 1984, pp. 97-112.

D. P russe, "Working at Home," *Perspectives*, Statistics Canada, Catalog no. 75-001-XPE, 1998, pp. 16-23.

J.H. Pratt, "Home Teleworking: A Study of Its Pioneers," *Technological Forecasting and Social Change*, 25, 2000, pp. 1-14.

J.H. Pratt, *1999 Telework America National Telework Survey: Cost/Benefit of Teleworking to Manage Work/Life Responsibilities*, International Telework Association and Council, 1999.

J.H. Pratt, "Asking The Right Questions About Telecommuting: Avoiding Pitfalls in Surveying Homebased Work," *Transportation*, 27, 2000, pp. 99-116.

Public Service Alliance of Canada, *Go home and Stay There?: A PSAC Response to Telework in the Federal Public Service*, Ottawa: PSAC, August 1993.

Public Service Alliance of Canada, *Delivering Public Services from Home: Telework in the '90s*, Ottawa: PSAC, February 1996.

D.B. Rathbone, "Telecommuting in the United States," *ITE Journal*, December, 1992, pp. 40-45.

B.R. Rowe and M.R. Bentley, "The Impact of Family on Home-Based Work," *Journal of Family and Economic Issues*, 13, 1992, pp. 279-297.

I. Salomon and M. Salomon, "Telecommuting: The Employee's Perspective," *Technological Forecasting and Social Change*, 25, 1984, pp. 15-28.

J.H. Snider, "The Information Highway as Environmental Menace," *The Futurist*, March-April 1995, pp. 16-21.

Statistics Canada, *Summary Report of Statistics Canada's Telework Pilot*, Ottawa: Treasury Board, 1994.

Statistics Canada, *Summary Report of Statistics Canada's Telework Pilot*, Catalog no. 75F0008XPR, January 1995.

Telecommute America, "Disasters Prompt Drive Toward Virtual Work," *The Futurist*, September-October 1996, pp. 48-50.

Treasury Board of Canada Secretariat, *Managing Better: Evaluation of Telework Pilot Policy – Findings*. Ottawa: Evaluation, Audit and Review Group of the Treasury Board Secretariat, 1996.

U.S. Department of Transportation, *Transportation Implications of Telecommuting*. Washington, D.C., U.S. Department of Transportation, April 1993.

M. Van Sell and S.M. Jacobs, "Telecommuting and Quality of Life: A Review of the Literature and a Model for Research," *Telematics and Informatics* 11(2), 1994, pp. 81-95.

T. Weijers, R. Meijer, and E. Spoelman, "Telework Remains 'Made to Measure': The Large Scale Introduction of Telework in the Netherlands," *Futures* 24, 1992, pp. 1048-1055.

R.D. Westfall, "The telecommuting paradox. *Information Systems Management* 14(4), 1997, pp. 15-20.

R.D. Westfall, "The Microeconomics of Remote Work," in *The Virtual Workplace*, M. Igbaria and M. Tan (eds.), Hershey, PA, USA, Idea Publishing Group, 1998, pp. 338-358.

WestGroup Research, *Telecommuting Market Research — 1999 Executive Summary*. Regional Public Transportation Authority (Valley Metro), 1999. <http://www.valleymetro.maricopa.gov/99-tele.html>

J.-R. Yen and H.S. Mahmassani, "Telecommuting Adoption: Conceptual Framework and Model Estimation," *Transportation Research Record* 1606, 1997, pp. 95-102.

Comments by Doug Kruse, Ph.D., *Professor, Rutgers, the State University of New Jersey*

Doherty, Andrey, and Johnson did an excellent job in pulling together a very wide and diverse set of information in their paper on the economic and social impacts of telework.* Telework obviously raises a variety of issues for employers, employees, families, and communities, and this review does a very nice job in surveying these issues and assembling research findings.

This response highlights a few of those issues and adds some information. As a labor economist, I first approach labor market issues by thinking in terms of labor supply and labor demand. On the labor supply side, the pay level that people are willing to accept for telework vs. on-site work is one convenient and powerful way of summarizing the perceived advantages and disadvantages of telework. If would-be teleworkers are generally willing to accept 5-10% lower pay for telework, as one study found, this suggests that the personal advantages are generally seen as outweighing the disadvantages. This assumes, however, that people are well informed about telework and know what they're getting into. It would be very interesting to see if these answers change as people experience telework. The actual pay levels appear to be no lower among teleworkers than among non-teleworkers, suggesting either that they do not really accept lower pay, or that if they do, this is counterbalanced by their generally higher productivity. Research is needed to sort out what's going on with the relative pay levels. What do they tell us about the perceived advantages and disadvantages of telework, and the productivity levels of teleworkers? Also, to what extent will these desired and actual pay differences generalize to potential teleworkers? Research on this would be very valuable for pinning down the potential advantages of expanded telework for employees and employers.

Another important labor supply issue is that telework may expand the available labor force. The labor force is predicted to grow more slowly over the next 10 years than it has the past 20 years, raising concerns about employers' ability to fill jobs (Fullerton, 1999). Telework may allow employers to tap underutilized sources, especially (as the paper notes) caregivers and people with disabilities.

Regarding caregivers, Edwards and Field-Hendrey (forthcoming) find that the presence of children, elders, and a spouse with a disability predict a greater likelihood of women doing home-based work as opposed to on-site work. The economic dependency ratio, measuring the proportion of non-workers to workers, is not predicted to change much in the next 10 years, but it will substantially increase over the next 50 years as the baby-boom generation retires (Bureau of the Census, 1996). Many of the retirees will need assistance at home, creating even more pressure for home-based telework by family members.

*A nice illustration of the relevance of the telework issue is provided by my experience in delivering these comments at the telework symposium. I became ill two days before the symposium and my doctor strongly advised me against traveling, so I could not attend. Nonetheless I could still be quite productive by finishing the comments on my home computer, sending them off using my home fax, and having them read at the symposium. While this was not as good as personally attending (in particular, since I was not able to engage in discussion, and to meet new people in this area and do productive schmoozing with existing colleagues and acquaintances), the technologies nonetheless increased my productivity by allowing me to participate.

Doug Kruse © 2000. All rights reserved.

This project was funded under a purchase order contract from the Office of the Assistant Secretary for Policy. Points of view or opinions stated in this document do not necessarily represent the official position or policy of the Department of Labor.

Telework also has substantial potential to increase employment opportunities for people with disabilities. Only about one-third of working-age people reporting work disabilities are employed in the course of a year (Burkhauser et al. 2000). Only one-fourth of working-age people with severe disabilities are employed in a month, leaving over 11 million without jobs (McNeil, 2000: Table 1). If this latter group were fully included in the labor force, the labor force would expand by almost 8%.

Telework may be especially relevant to those whose disabilities limit mobility. The importance of mobility impairments is shown by the findings that only one-sixth of those who have difficulty going outside alone are employed (McNeil 2000), and that the employment probability of a person with a disability is increased 18-20% points by the availability of a vehicle s/he can drive (Berkowitz et al. 1999; Schur 2000). Mobility limitations can discourage obtaining on-site work due to the extra time and energy that may be required in commuting, the need that some people have for physical assistance, and the financial expense of obtaining accessible transportation. For example, the average cost of modifying a vehicle for use by a person with a spinal cord injury is \$6500, and the cost of extensive modifications can easily exceed the price of a new vehicle (Berkowitz et al. 1999).

These problems of mobility limitations can be largely avoided with home-based work. In addition, home-based work may be especially suitable for those with medical or self-care needs that are met more easily with flexible schedules centered around the home. The importance of home-based work for people with disabilities is shown by the following numbers, based upon data from Current Population Survey supplements in 1991 and 1997 (Kruse and Hyland 1998).

Table 1 - Current Population Survey of Home-based Workers with and without Disabilities

	With disabilities		Without disabilities	
	1991	1997	1991	1997
	(1)	(2)	(3)	(4)
Percent of workers doing:				
Any home-based work for pay	9.2%	15.1%	6.6%	9.8%
8+ hrs./week	5.1%	6.6%	3.4%	4.6%
20+ hrs./week	3.9%	4.1%	2.0%	2.8%
Percent doing any paid home-based work if in:				
Private sector	2.1%	5.7%	1.8%	4.9%
Government	0.2%	6.9%	1.4%	5.6%
Self-employment	51.0%	63.5%	49.5%	52.6%

These data indicate that almost one-sixth of workers with disabilities were doing home-based work for pay in 1997, compared to one-tenth of workers without disabilities. The rate of paid home-based work was only slightly higher among private sector and government employees with disabilities than among their counterparts without disabilities, while the difference was more pronounced among self-employed workers. The comparison between 1991 and 1997 is limited by the fact that the questions changed on whether home-based work was for pay or not. The data nonetheless suggest that the prevalence of paid home-based work increased over this time, particularly among workers with disabilities (an increase of almost 6 percentage points, compared to an increase of 3 percentage points among workers without disabilities).

Computer technologies, which are a key element in the growth of telework, may be especially important for people with disabilities both in helping compensate for basic limitations and in enhancing their employment and earnings prospects. Computer use at work appears to erase pay differences between workers with and without spinal cord injuries, while there is a large pay gap among non-users of computers (Krueger and Kruse 1995). In light of this, it is somewhat surprising that only half of home-based workers with disabilities use computers in their home-based work, compared to three-fifths of home-based workers without disabilities (while 90% of each group use some form of telecommunications equipment, including a computer, fax, telephone, or other equipment) (Kruse and Hyland 1998). This lower use of computers among workers with disabilities may be partly explained by reduced opportunities for developing computer skills, resulting from lower access to computer training and a lower likelihood of having a computer or access to the Internet (Kruse et al. 1996; Kaye 2000).

The preceding discussion indicates that telework may play an important role in increasing employment opportunities for people with disabilities, and in allowing employers to tap into an underutilized pool of human resources. This does, however, have potential problems. In particular, as the paper notes, telework may reinforce the isolation faced by many people with disabilities, and may reduce the pressure to make workplaces fully accessible.

A final labor supply issue which deserves mention is the aging workforce. The annual workforce growth rate for those age 55 or older is projected to be 4.0% through 2008, compared to only 0.5% for those age 25 to 54 (Fullerton 1999). Telework may allow employers to more easily tap the growing pool of senior citizens. The rate of home-based work is already highest among workers age 65 or older (both those with and without disabilities) (Kruse and Hyland 1998). Such work may be even more attractive with the demise of the Social Security Retirement Earnings test.

On the labor demand side, there are many issues that the paper addresses well. Obviously there are a number of advantages to telework for firms. Challenges include determining what types of jobs are appropriate, how to keep worker productivity up, and how to ensure that workers are being dealt with fairly. The earlier point about teleworkers' pay is clearly important in labor demand as well as in labor supply: the demand for teleworkers may be increased by lower required pay levels (if teleworkers will in fact accept lower pay in exchange for the amenities of telework) and by higher productivity levels. Regarding the latter, some studies find higher productivity among teleworkers, but there is a fair amount of variability, and the measures are generally opinion-based rather than quantitative. Even where there are apparent pro-

ductivity increases among current teleworkers, this may be a fairly select group, and it does not mean that we would necessarily see productivity increases if those who do not now telework began doing so. Nonetheless, a good amount of evidence indicates that work productivity generally increases when people have greater control of their lives and can set their work hours. Accordingly, there is little reason to think that increased telework will slow down productivity growth, and it may in fact help.

There are many other important issues raised in the paper. In particular the issues of transportation and community infrastructure are well discussed. One other issue should be raised. There is recent research on the role of employment in enhancing political and civic participation. This result can be achieved by through increased financial resources, civic skills, sense of efficacy, and exposure to potential political recruitment networks in the workplace (Schlozman et al. 1999; Schur 2000). Telework may provide some of these benefits, but it probably allows less development of civic skills and exposure to social networks. One potential concern is that increased telework may hurt the already-low levels of voter turnout and other forms of civic participation. It is possible, however, that this may be counteracted in other ways, such as by increased interaction through the Web.

In sum, telework will clearly be an increasingly important part of 21st century employment. This review does a nice job of summarizing the current state of our knowledge, and highlights a variety of issues on the future of telework that will warrant much more discussion and research.

References

Monroe Berkowitz, Paul O'Leary, Douglas Kruse, Carol Harvey, *Spinal Cord Injury: An Analysis of Medical and Social Costs*, New York, Demos Publications, 1998.

Richard Burkhauser, Mary Daly, Andrew Houtenville, "How Working Age People with Disabilities Fared Over the 1990s Business Cycle," Rehabilitation Research and Training Center, Cornell University and the Lewin Group, January 2000.

Bureau of the Census, "Population Projections of the United States by Age, Sex, Race, and Hispanic Origin, 1995-2050," Report P-25, Washington, D.C.: Bureau of the Census, 1996.

Edwards, Linda, and Elizabeth Field-Hendrey, Forthcoming: "Home-based Work and Women's Labor Force Decisions," *Journal of Labor Economics*.

Howard N. Fullerton, Jr., "Labor Force Projections to 2008: Steady Growth and Changing Composition," *Monthly Labor Review*, Vol. 122, No. 11, November 1999.

H.S. Kaye, "Computer and Internet Use Among People with Disabilities," *Disability Statistics Report*, 13, Washington D.C., U.S. Department of Education, National Institute on Disability and Rehabilitation Research, 2000.

Alan Krueger and Douglas Kruse, "Labor Market Effects of Spinal Cord Injuries in the Dawn of the Computer Age," *National Bureau of Economic Research Working Paper No. 5302*, October 1995.

Douglas Kruse, Alan Krueger, Susan Drastal, "Computer Use, Computer Training, and Employment Outcomes Among People with Spinal Cord Injuries," *Spine*, Vol. 21, No. 7, April 1996, pp. 891-896.

Douglas Kruse and MaryAnne Hyland, *Telecommuting and Other Home-based Work: Differences by Disability Status*, Draft, School of Management and Labor Relations, Rutgers University, December 1998.

John McNeil, *Employment, Earnings, and Disability*, U.S. Bureau of the Census, Washington, D.C., 2000.

Kay L. Schlozman, Nancy Burns, Sidney Verba, "What Happened at Work Today?": A Multistage Model of Gender, Employment, and Political Participation," *Journal of Politics*, Vol. 61, No. 1, February 1999, pp. 29-53.

Lisa Schur, *Do Jobs Create Active Citizens? Disability, Employment, and Political Participation*, Draft, School of Management and Labor Relations, Rutgers University, October 2000.